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AN EVALUATION OF THE MLRS IFCS MMI DEVELOPED FOR THE TRIS EFFORT

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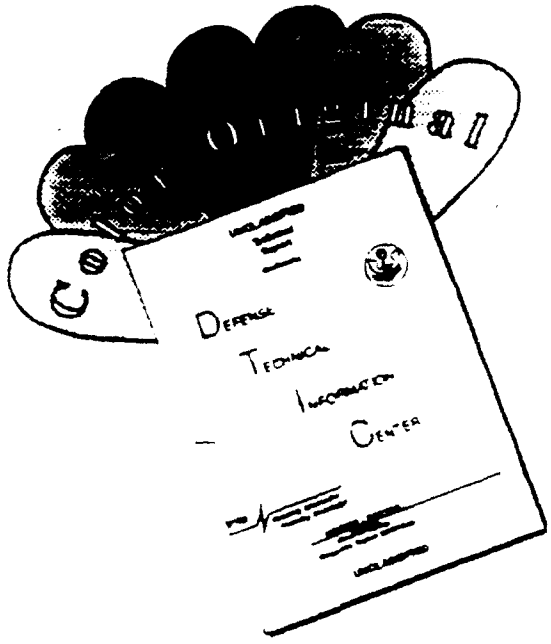

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As a result of the efforts of the MLRS IFCS study, a team was created to assemble a Technical Risk Investigation System (TRIS).As a part of the TRIS effort, a preliminary graphical man-machine interface has been constructed to investigate the risks associated with displaying MLRS IFCS system data using pull-down and pop-up menus, icons and color schemes. This report describes the equipment used to implement this interface, and it documents the work that has been completed on this interface.

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Introduction

The man-machine interface (MMI) used in the present Multiple Launch Rocket System Fire Control System (MLRS FCS) has been an object of concern throughout the technical community. The MLRS FCS MMI has functioned adequately and has taken advantage of the technology that was available at the time of its design. However, the present interface is very complicated and is not efficient in terms of trainability or ease of operation.

With today's advanced technology, it has become possible to develop a graphical interface that will allow a user to easily see the status of a system at a glance. This is possible through the use of pull-down and pop-up menus, icons, and color schemes which are used to signify status to the user. A properly designed graphical interface could be a suitable alternative for the complex, menu-driven interface used in the present MLRS FCS.

Due to the increasing obsolescence of the technology used in the present day MLRS FCS system, a design effort has begun on the MLRS Improved Fire Control System (IFCS). As a result of the efforts of the MLRS IFCS study team, a team was created in February 1992 to assemble a Technical Risk Investigation System (TRIS). As part of the TRIS effort, a preliminary graphical man-machine interface has been constructed to investigate the risks associated with displaying MLRS IFCS system data using pull-down and pop-up menus, icons and color schemes.

The purpose of this report is to document the work that has been completed on the preliminary MLRS IFCS Man-Machine Interface. This report will describe the equipment and prototyping methods used to implement the graphical interface, and it will describe the functionality of the current graphical interface.

I. Equipment and software used

The equipment used to develop the graphical man–machine interface consists of a Silicon Graphics IRIS 4D/310VGX machine with 2 1.2 Gbyte disk drives and 32 Mbytes of RAM and a prototyping software application package called Virtual Applications Prototyping System (VAPS, Version 2.05).

II. Evaluation of equipment and software

The prototyping applications package, VAPS, used to develop the interface is a powerful tool that allows a user to design, test, and implement an interface very rapidly. The VAPS design package that has been used consists of five main editors. These editors are the object editor, the logic editor, the integration editor, the font editor, and the runtime editor.

A VAPS object library contains several predefined types of objects with different types of behavior such as potentiometers, dials, buttons, lights, etc. In the object editor, the user creates an object. Then he defines his object to be an object contained in the VAPS library. By connecting object plugs in the integration editor or writing code in the logic editor, the user can define his object to have a certain functionality. Then, the user can immediately go to the runtime editor to see the resulting object behavior. By immediately seeing the results of his object definition, the user can immediately tell if the behavior of his design corresponds to his vision of how it should be behaving.

This feature of the VAPS package has been very helpful to the engineers designing the preliminary MLRS IFCS MMI. Since the interface is in the conceptual design stage, the VAPS method of rapid implementation has been very effective in allowing designers a chance to quickly see the results of the ideas they would like to implement. Since the VAPS application package is run on the Silicon Graphics machine mentioned previously, the combination of the Silicon Graphics machine and the VAPS package has been well–suited to fit the needs of the MLRS IFCS MMI design team.

III. Problems encountered

During the initial design process, one problem has been encountered with the VAPS Version 2.05 product. Occasionally, while inside the VAPS design tool, a segmentation fault would occur and the user would be booted out of the design tool. If the user happened to be designing a frame when the design tool was involuntarily closed, and the user tried to use that same frame later at runtime, the objects within the frame would not act properly.

A call has been placed to VPI support, and it has been found that there is a bug in Version 2.05. If the Preserve Environment option, which can be accessed in the User Settings menu, is set to "yes", this problem will occur. After setting this option to "no", the problem has not occured again.

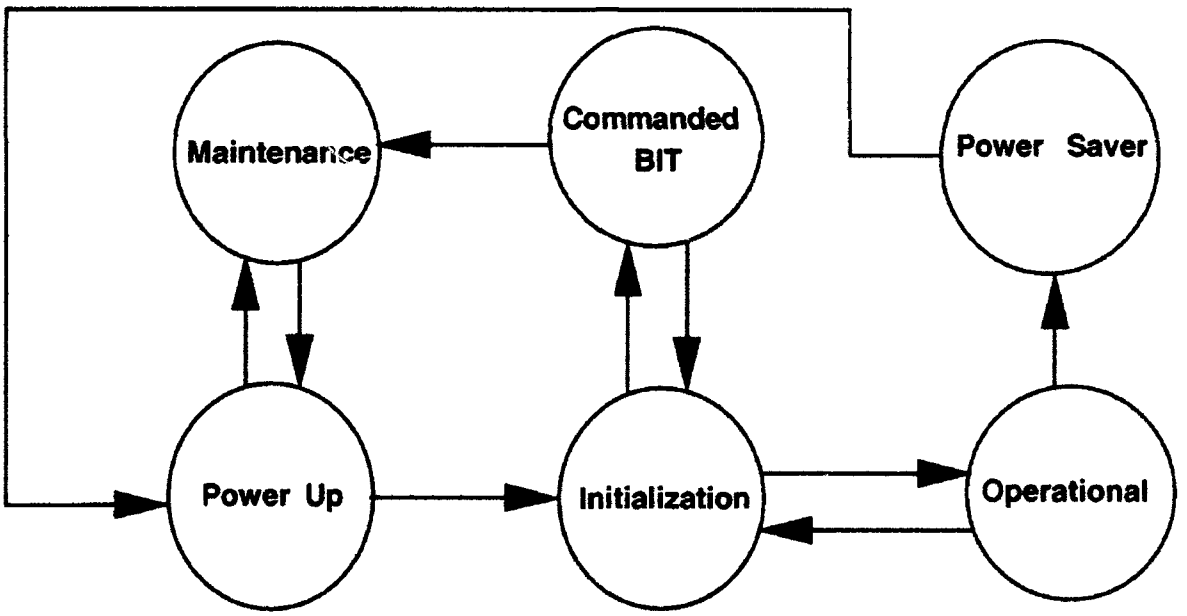
IV. Current functionality of the MLRS IFCS MMI developed for the TRIS effort

The specification for the functionality of the MLRS IFCS MMI can be found in the Missile Command Specification, System Specification for the Fire Control System for the Multiple Launch Rocket System, MIS–46307A, CODE IDENT 18876. All of the work completed on the interface complies with this specification.

In the specification, MIS–46307A, the basic requirement for the MLRS IFCS MMI is that it will consist of six operational modes. The six operational modes shown below in Figure 1 are:

1. Power up mode
2. Initialization mode
3. Operational mode
4. Commanded BIT mode
5. Power saver mode
6. Maintenance mode

Figure 1. IFCS operational modes



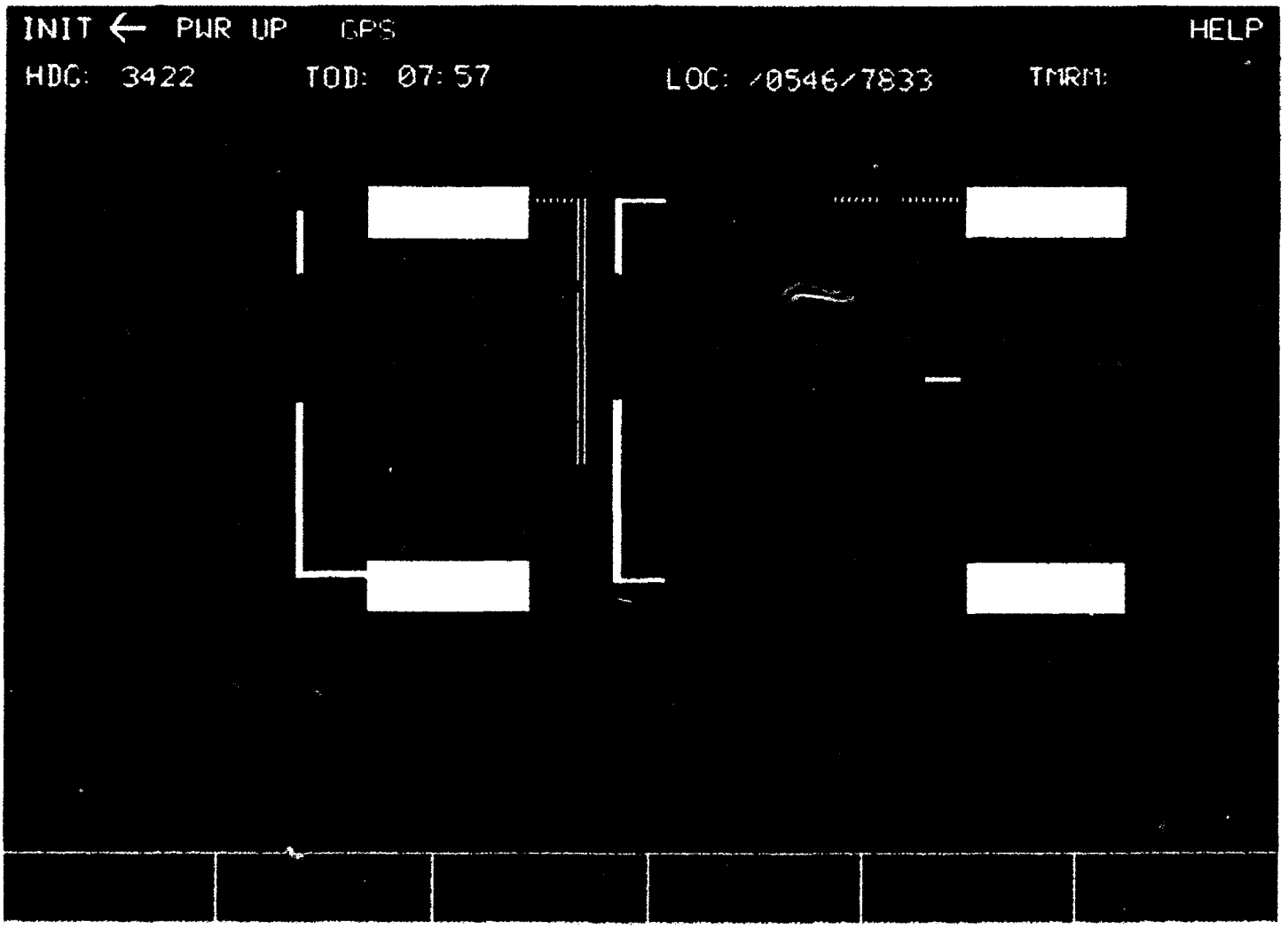
The ability to transition from one mode to another is defined in the specification. The arrows shown in Figure 1 indicate the defined transitions that can be made from one mode to another. For example, from the operational mode, a user can only transition to the power saver mode or the initialization mode. Likewise, the user can only transition to the operational mode from the initialization mode.

Now that the six operational modes have been established, the following sections will describe the current display for each of the operational modes and the functionality of each.

A. Power up mode

According to MIS–46307A, the Power–Up state is entered when the operator activates the system power switch or when a system reboot is requested. The current display for the power up operational mode is shown below in Figure 2.

Figure 2. Power up mode display



Within the current power up mode display, there are six types of icons. The icons are the:

1. Line Replacable Unit (LRU) icon
2. Circuit Card Assembly (CCA) icon
3. Cabling icons
4. Global Positioning System (GPS) icon
5. Mode transition button icon
6. Help balloon
7. Vehicle status bar

Each of these features and their functionalities will be discussed in the following section.

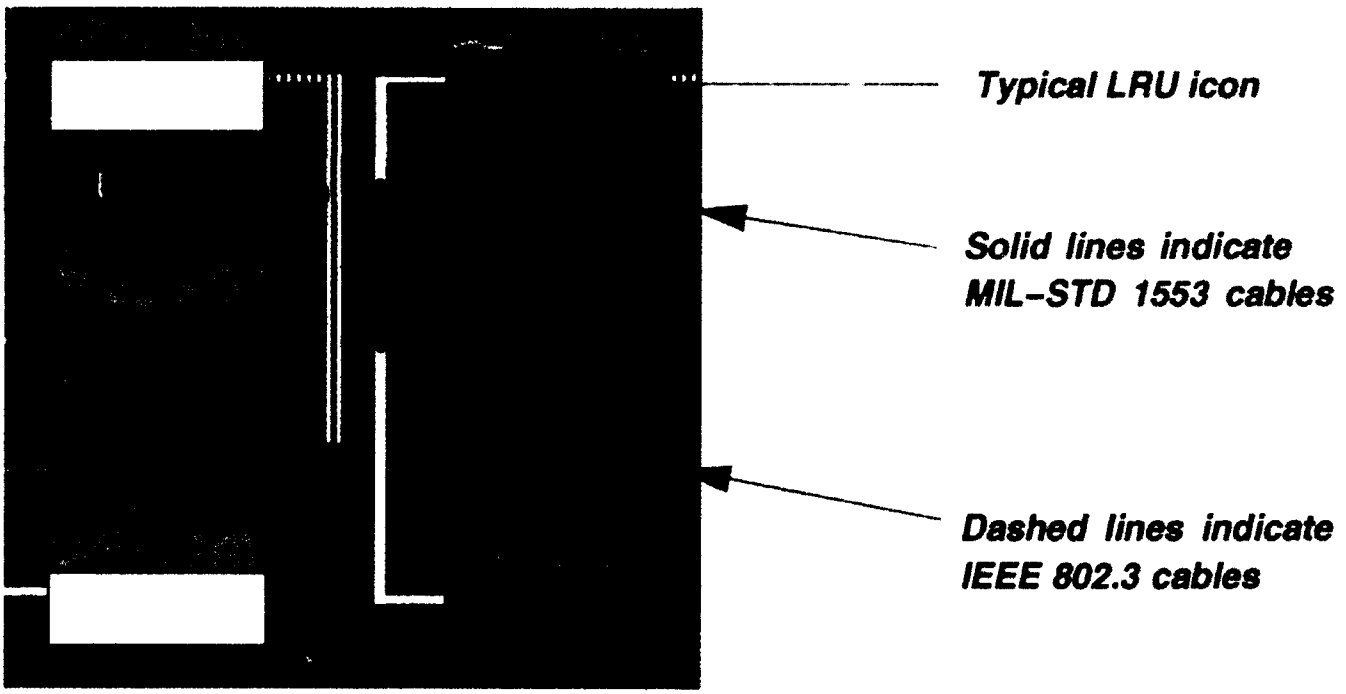
Within the MLRS IFCS, there are eleven functional entities. For the purpose of this report, each functional entity has been considered an LRU, and each of these LRUs contains five CCAs. Each of these LRUs has a specific function that it will accomplish in order for the IFCS to operate correctly. The eleven LRU's within the MLRS IFCS are listed below in Table 1.

LRU	*Acronym*
1. Position Determining/Navigation	***POS/NAV***
2. Weapon Interface Unit	***WIU***
3. Launcher Interface Unit	***LIU***
4. Main Processor	***MP***
5. Meteorological Sensor	***MS***
6. Global Positioning System	***GPS***
7. Weapon Power Unit	***WPU***
8. Fire Control Panel	***FCP***
9. Communication Processor	***CMP***
10. Power Management Unit	***PMU***
11. Mass Storage Device	***MSD***

Table 1. MLRS IFCS LRUs and their acronyms

The IFCS is capable of testing each LRU and CCA to determine if they are operating correctly. Also, the MIL-STD 1553 cables and the IEEE 802.3 cables that connect each LRU together can be tested. On the initial power up mode display, each LRU and the cables that connect them together are represented by icons seen below in Figure 3.

Figure 3. Graphical representation of the MIL-STD 1553 and IEEE 802.3 cabling between LRU's



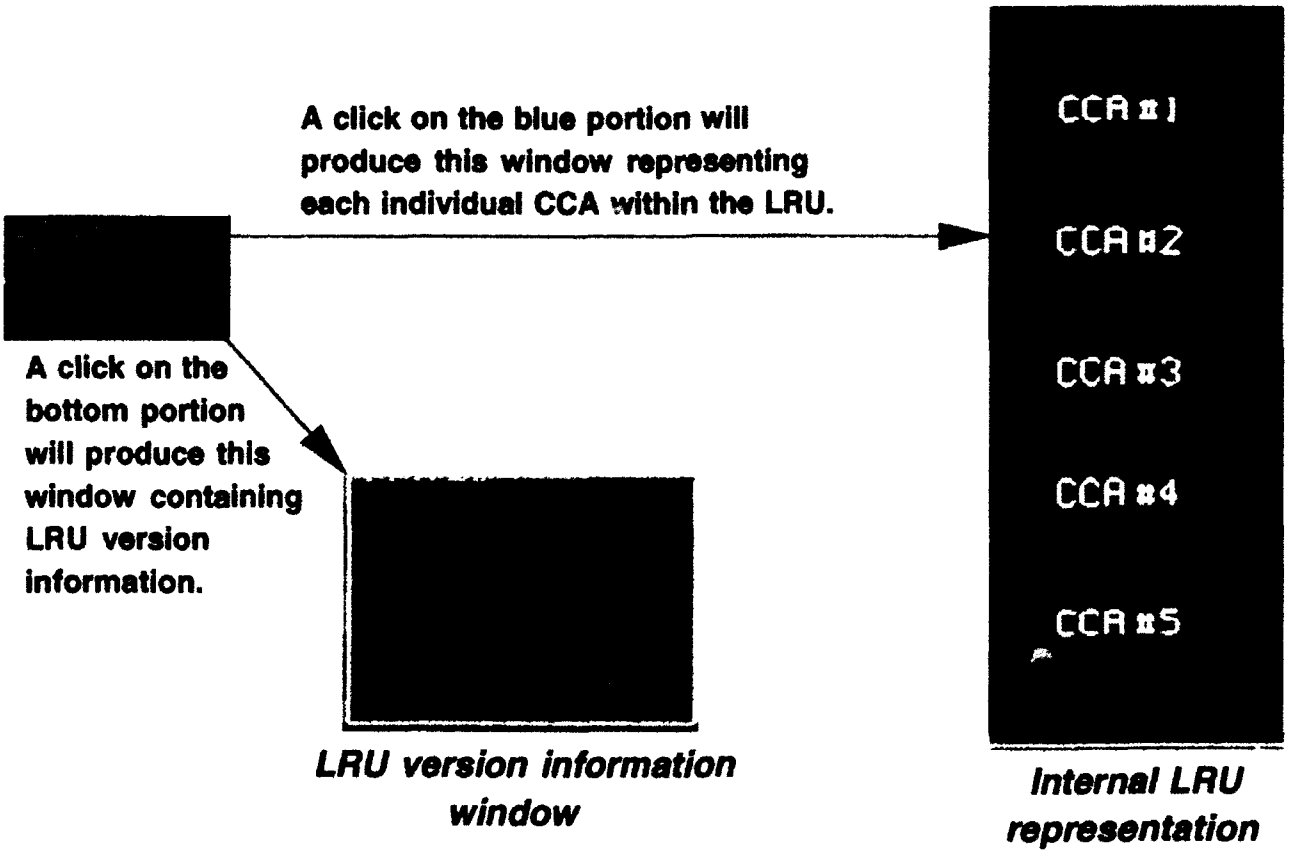
The icon seen below in Figure 4 represents a typical LRU. The top blue portion contains the name of the LRU. When the user clicks on this active area, a window will pop up containing LRU version information. The bottom portion of the icon indicates the status of the LRU. The status of the LRU is indicated to the user by the color of the bottom portion. The color scheme used to indicate the LRU's status in the bottom portion of the icon is:

Color	Meaning
Red	Failure
Yellow	Testing in progress
Green	Good

Figure 4. LRU icon

When the user clicks on the active area contained in the bottom portion of the LRU icon, a window will pop up containing status information. This window contains icons that represent each of the CCAs inside the LRU. Figure 5, below, depicts the original LRU icon and the windows that result from clicking on either the top or bottom portion of the icon.

Figure 5. LRU icon and resulting status windows



In Figure 6, below, examples of the Internal LRU representation window and the resulting status windows are shown. The Internal LRU representation window is seen when the bottom colored portion of an LRU icon is selected. Inside the Internal LRU representation window, there are five CCA icons which represent the five CCAs that are internal to the originating LRU.

The CCA icon's active areas function in the same manner as the LRU icon's active areas. When the user clicks on the top portion of a CCA icon, a window will pop up containing CCA version information. When the user clicks on the bottom colored portion, a window will pop up containing CCA status information. The color scheme used to indicate LRU status remains the same for CCA status.

Color	Meaning
Red	Failure
Yellow	Testing in progress
Green	Good

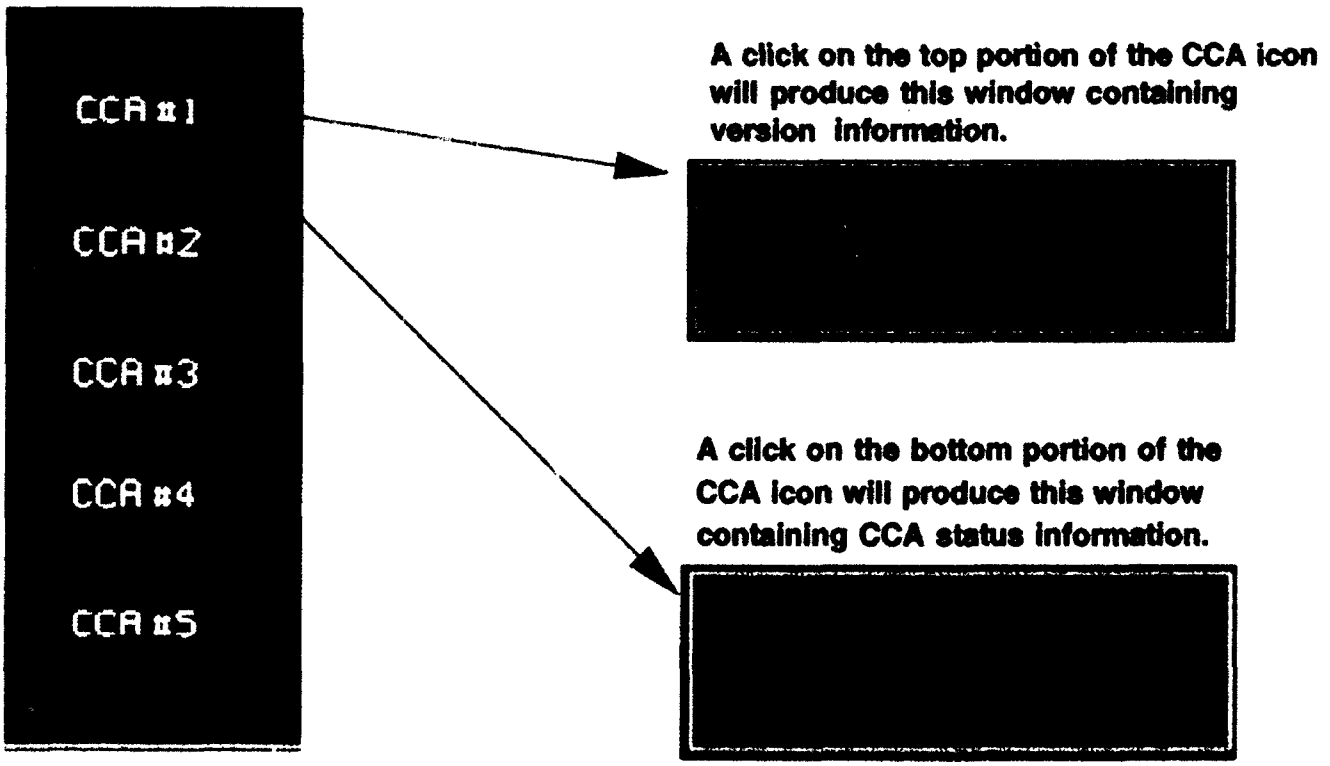


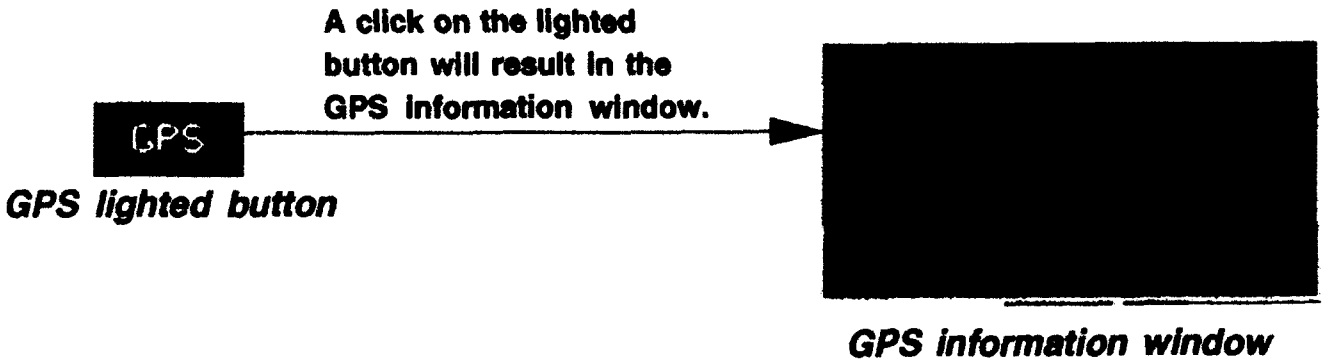
Figure 6. Internal LRU representation

Among the miscellaneous functions of the power up display are GPS status capability, mode transtition buttons, the help option, and a vehicle status bar. The GPS status capability has been implemented using a lighted button, seen below in Figure 7. The status of the GPS is indicated using a similar color scheme previously discussed:

Color	Meaning
Red	GPS is not seeing enough satellites to get a position fix
Yellow	GPS is only seeing the minimum number of satellites to get a position fix
Green	GPS is seeing more than enough satellites to get a position fix

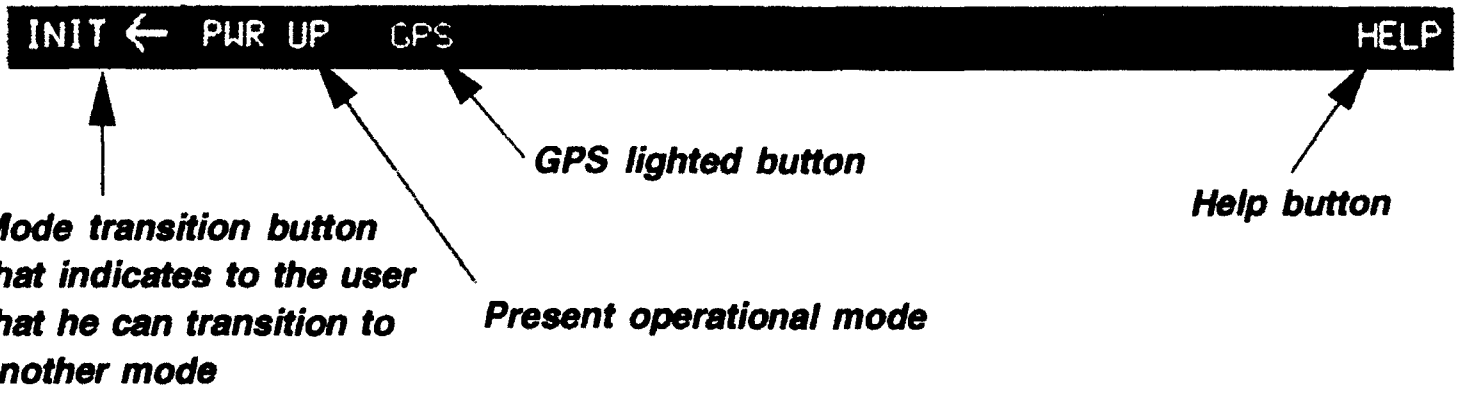
An operator can see at a glance if the GPS system is functioning properly or if it is not seeing all of the necessary satellites. Another feature of the GPS status capability that has been implemented is that by clicking on the GPS lighted button, a window pops up containing additional information that might be necessary for the operator to perform his duties.

Figure 7. GPS status capability



Another function included in the power up display is the ability to transition from one mode to another. An example of a mode transition button is shown below in Figure 8. The current operational mode is indicated by the dark blue button, and any operational modes that can be reached from the power up mode are shown as light blue buttons containing transition arrows. By clicking on a light blue button, the user can transition to another mode. In this example the user could transition to the initialization mode.

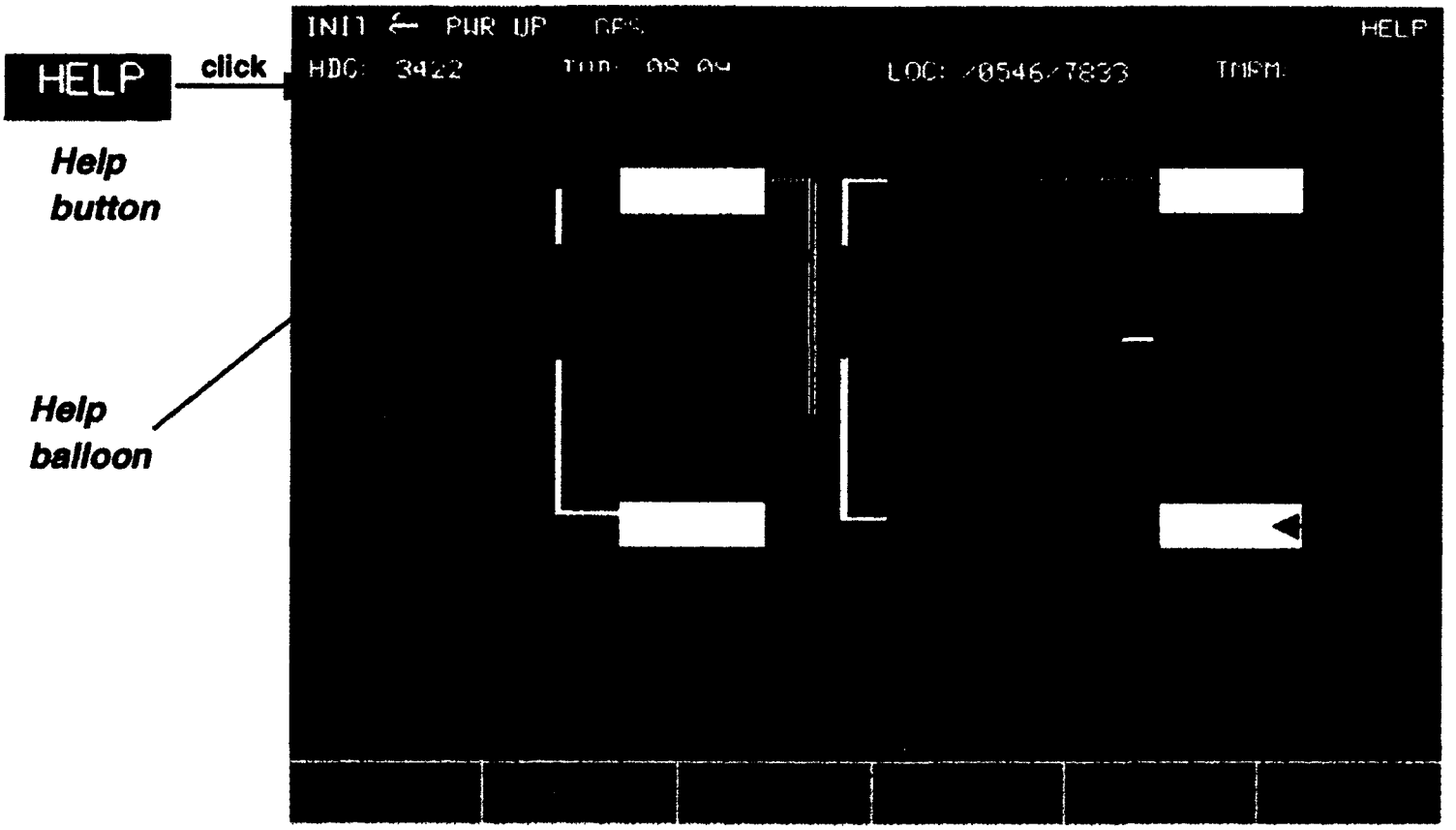
Figure 8. Mode transition button, GPS status capability, and the help option for the power up mode display



Also included in Figure 8, above, are the GPS lighted button and the help button. For an explanation of the GPS lighted button and its resulting status window, see page 10. The help button is an option that the user may choose if he would like an indication of the active areas that are available for his selection.

When the user selects the help button, help balloons appear on the display which indicate to the user which active areas are available for selection. The help button and the corresponding help balloons for the power up display are shown below in Figure 9.

Figure 9. Help button and corresponding help balloons



A final function included in the power up display is the vehicle status bar, shown below in Figure 10. This status bar displays vital vehicular information to the user. This status bar presently contains the heading of the MLRS vehicle, the time of day, and the location of the vehicle.

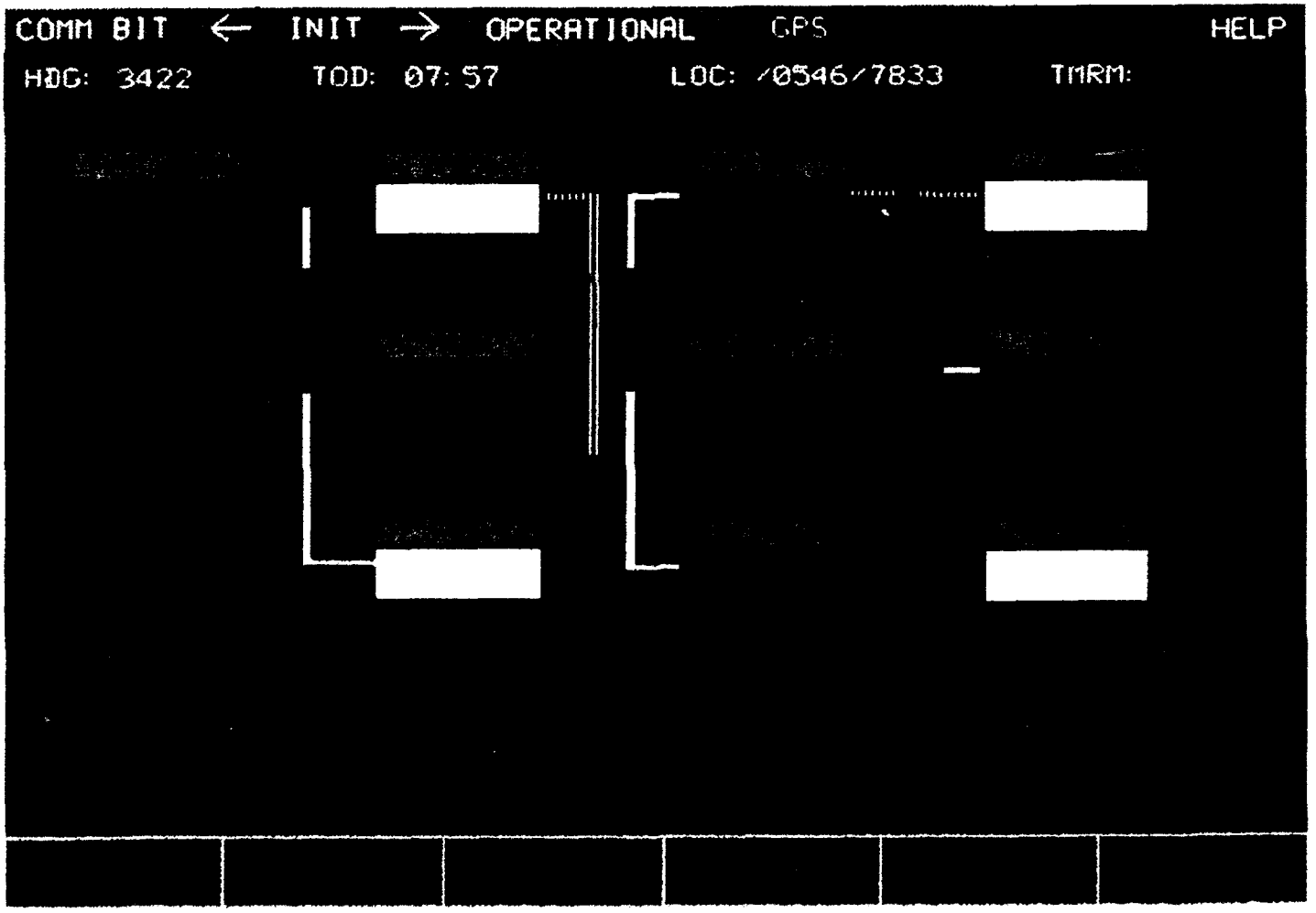
Figure 10. Vehicle status bar

B. Initialization mode

According to MIS–46307A, the Initialization state is entered automatically from the Power Up state. All the LRU's are loaded with software and tested, the hardware/software system configuration is verified, and the operator is given the opportunity to change the stored system set–up parameters. Since the interface developed for the TRIS effort does not support any realtime interaction with other devices, no loading or testing of hardware or software is actually done. Therefore, the current display does not support the automatic transition from the Power Up state to the Initialization state. To transition to the Initialization state, the user must select a mode transition button in the power up display.

The current display for the initialization operational mode is shown below in Figure 11.

Figure 11. Initialization state display

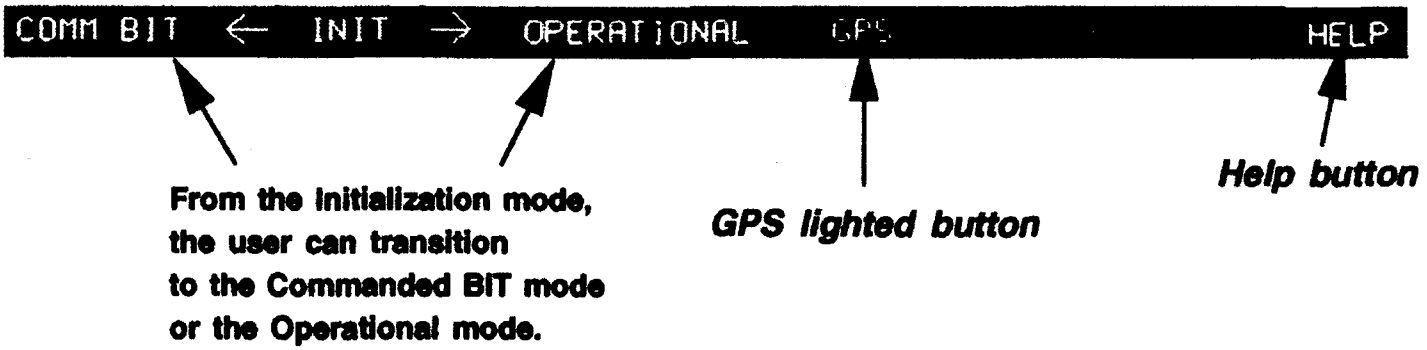


The seven types of icons contained in the initialization mode display are identical to the seven icons in the power up mode display. They are the:

1. LRU icon
2. CCA icon
3. Cabling icons
4. GPS icon
5. Mode transition button icon
6. Help balloon
7. Vehicle status bar

The initialization mode display is essentially identical to the power up mode display. The only difference between the two displays in the current interface is the state destination of the mode transition buttons. The mode transition buttons for the initialization display are shown below in Figure 12. All other icons and their functionalities remain the same. For a description of these icons, see pages 5 – 12.

Figure 12. Mode transition buttons, GPS lighted button, and the help button for the initialization mode display

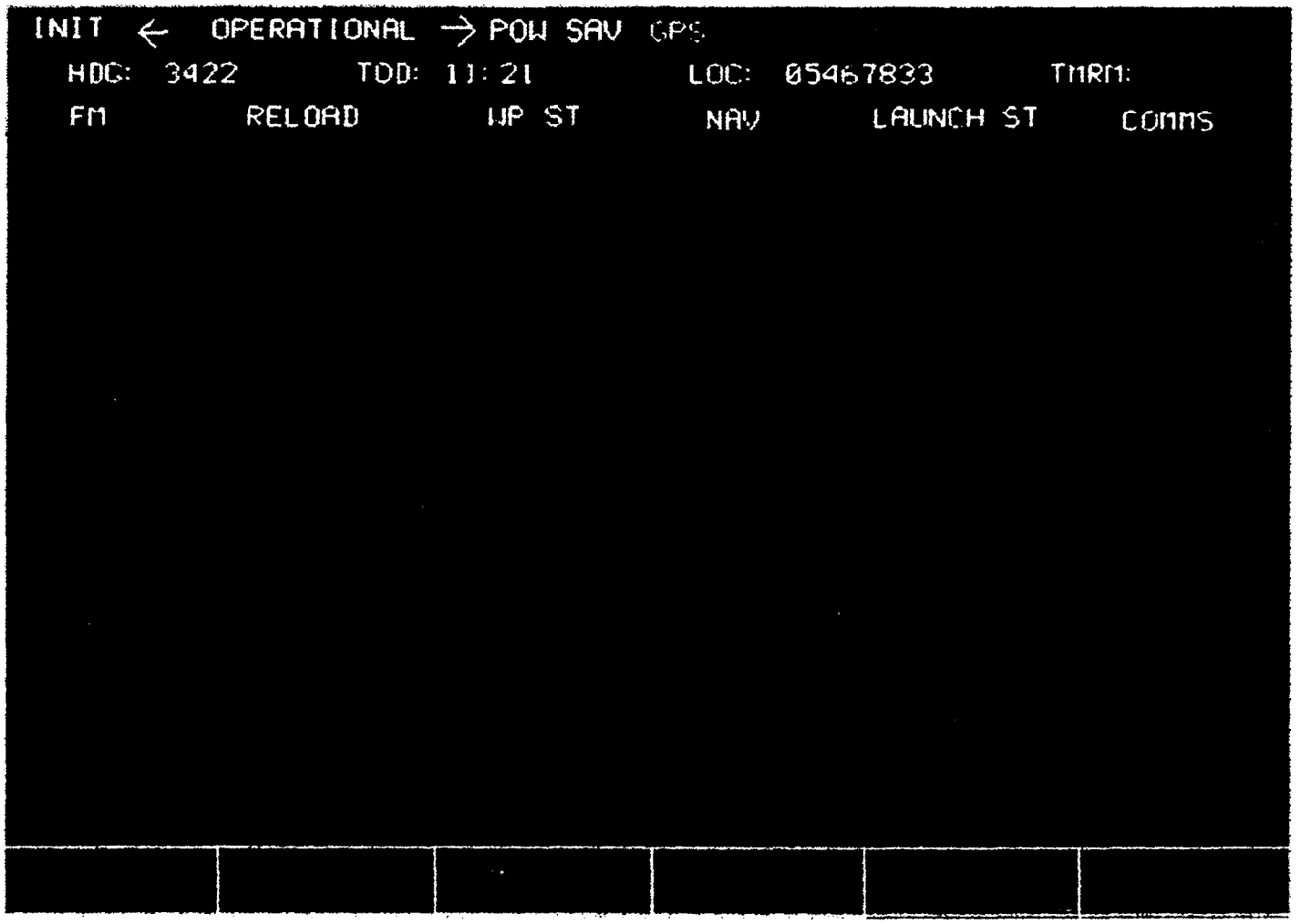


C. Operational mode

According to MIS–46307A, the Operational state is entered from the Initialization state when commanded by the operator. Within the operational state, the MLRS IFCS performs tasks such as receiving and performing fire missions, executing the short/no voltage test, and performing resource management. All of the work completed on the MLRS IFCS MMI operational state displays has been concentrated on performing fire missions.

The current top-level display for the operational mode portion of the interface is shown below in Figure 13. The functionality of each of the objects contained within the top-level display will be discussed separately in the following section.

Figure 13. Operational mode display



state displays has been concentrated on performing fire missions

1. Miscellaneous functions of the operational mode display

The operational mode portion of the man–machine interface requires several screens to display different types of data to the user. In the current interface, the operational mode displays consist of one top–level screen and two lower–level screens that a user has to transition to in order to shoot a fire mission. Within the top–level operational display and the two lower–level displays, there are a few miscellaneous options that retain their functionality throughout all levels of the operational display.

The first option that remains accessible within the top–level and lower–level displays is the mode transition button option shown below in Figure 14. The current operational mode is indicated by the dark blue button, and any operational modes that can be reached from the operational mode are shown as light blue buttons containing transition arrows. By clicking on a light blue button, the user can transition to another mode. In this example, the user could transition to the initialization or the power saver mode from the operational mode.

Figure 14. Mode transition buttons for the operational mode display

Also shown in Figure 14, above, is the GPS lighted button. This feature is accessible in all modes of the current interface. For a description of its functionality, see page 10.

Another feature that is implemented in all portions of the interface is the programmable key section of the display seen below in Figure 15. The six programmable key fields correspond to six hard keys that will be present on the IFCS control panel as required by MIS–46307A. These fields are present in all of the interface displays. However, in the current interface, the keys have only been programmed in the operational mode display. In this example, the two programmable key options available to the user are to return to the top–level operational mode display and select the MLRS key. At this point, the MLRS key has not been assigned a functionality.

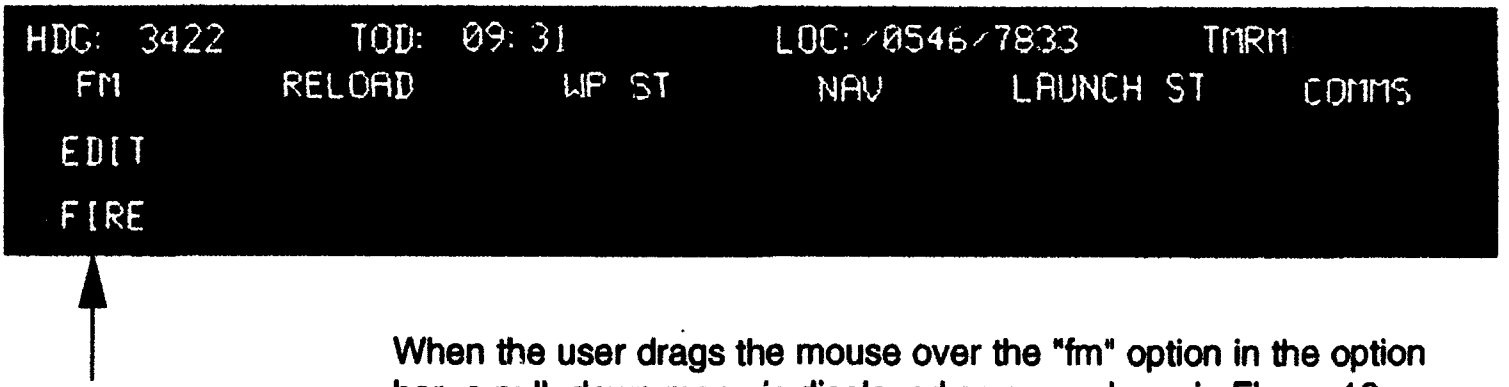
Figure 15. Programmable key fields

The operational mode display option bar, shown below in Figure 16, contains options that are available to the user inside the operational mode. There are several options included on the option bar including:

Option	Definition
1. FM	– Fire Mission
2. RELOAD	
3. WP ST	– Weapon Status
4. NAV	– Navigation
5. LAUNCH ST	– Launcher Status
6. COMMS	– Communications

In the current interface, the only option that has been defined is the fire mission option.

Figure 16. Operational mode display option bar



Fire mission pull–down menu

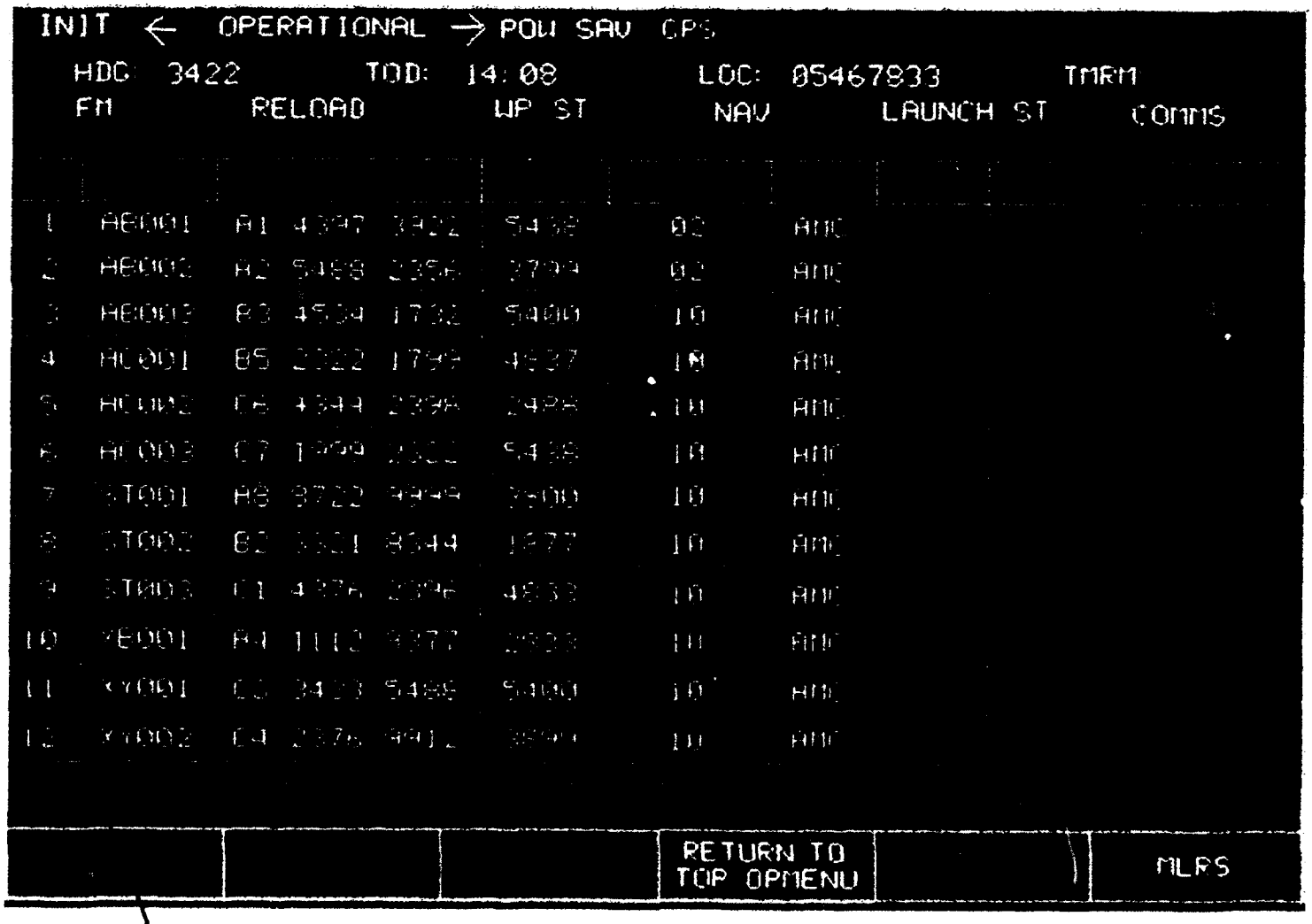
When the user drags the mouse over the "fm" option in the option bar, a pull–down menu is displayed as seen above in Figure 16. The user can ideally choose either to edit or fire a fire mission. However, the edit fire mission capability has not been developed in the current interface. Therefore, the only option that is availiable to the user in the top level of the operational mode display is fire a fire mission.

After choosing to fire a fire mission, the user is shown a list of up to twelve fire missions that are available to him. In the current display, no features have been added to allow the list of fire missions to change in any way, and the list is therefore fixed. The fire mission display containing the fixed list of fire missions is shown in Figure 17. By clicking on a fire mission number, the user can select which fire mission he would like to fire, and automatically transition to that fire mission.

The information given for each fire mission in the fire mission list shown in Figure 17 includes the following:

1. FM# – fire mission number
2. TG# – target number
3. FP – firing point
4. PH – park heading
5. #RNDS – number of rounds
6. CON – method of control
7. TTF – time to fire

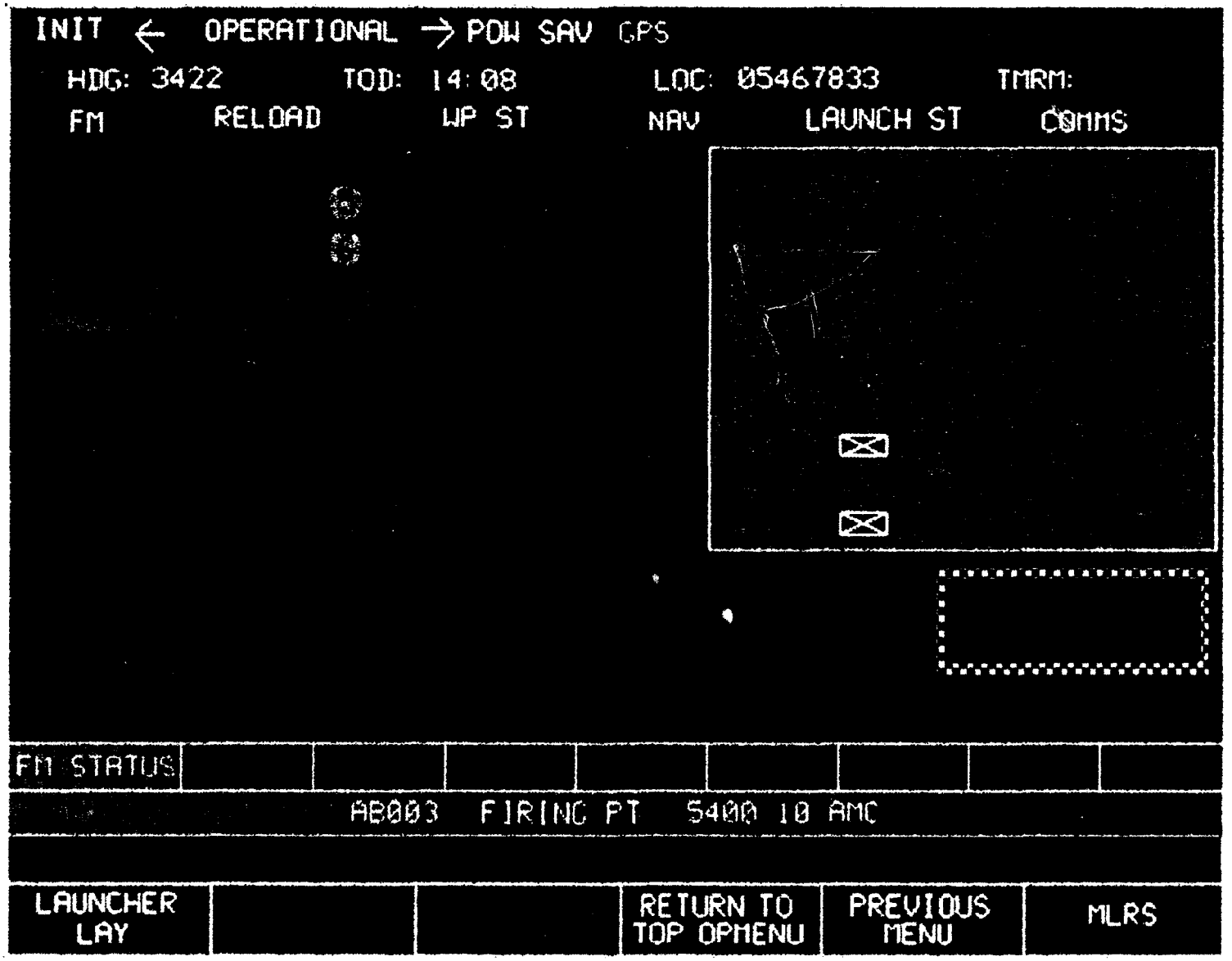
Figure 17. Operational mode display containing list of fire missions



2. Types of fire missions

In the current man-machine interface, there are two types of fire missions. The first type of fire mission fires twelve JED or M77 rockets (FM# 3 – 12). The second type of fire mission fires two JEE or ATACMS missiles (FM# 1 – 2). An example of a JED fire mission is shown below in Figure 18. Each of the features contained within the display will be discussed in the following section.

Figure 18. JED fire mission display

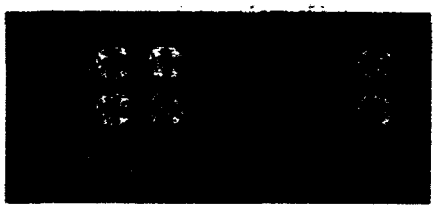


a. Features within a JED fire mission display

Within the JED fire mission display, there are several features that have been developed to inform the user of the status of the MLRS IFCS system before, during, and after a fire mission has been fired. These features have been developed by combining graphics and text into an easily understood set of status alerts. The following section contains the visual representation of each feature in the JED fire mission display and an explanation of its functionality.

Feature

Before



During

After

Figure 19. JED pod representation

Functionality

This feature is the **JED Pod Representation.** In Figure 19, the JED Pod Representation is seen as the user sees it before, during, and after a fire mission has been fired. Originally, if a rocket is present in the pod, a green circle will appear. As the rockets are fired, the circle will turn gray which alerts the user that the rocket has been fired. If a circle is red, the user is alerted to a rocket failure. The three conditions that can be identified by the user are:

Color	Condition
Green	JED present
Gray	Pod is empty
Red	Failure

Another feature that has been built into the JED pod represesentation is the ability to click on the pod or the "wp type" button and obtain a status report on each individual rocket in the pod or obtain weapon information for the weapon currently selected to fire. The graphical representation of the JED pod and the resulting information windows are shown below in Figure 20.

When the user clicks on either of the pod icons, a JED Pod Status Blowup will appear. This blowup will inform the user of the condition of each individual rocket in the pod and the reason for any problems that have occurred. In this example, rocket #1 in pod 2 has failed a built–in test. Therefore, in this simulation, the rocket will not be fired. When the user clicks on the WP TYPE button, a JED Weapon Information window will appear. This window contains weapon information such as type, version number, minimum range and maximum range, etc.

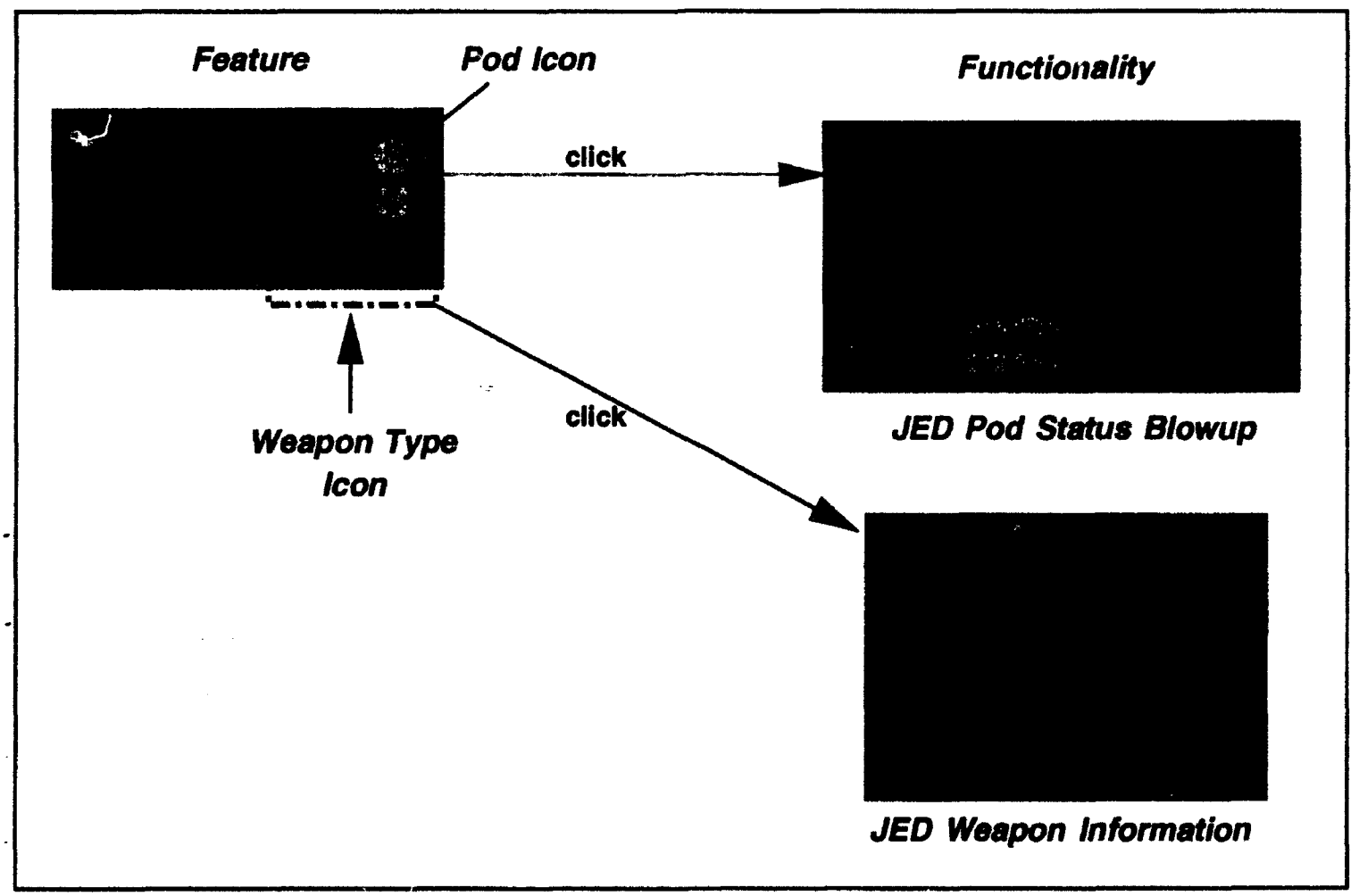
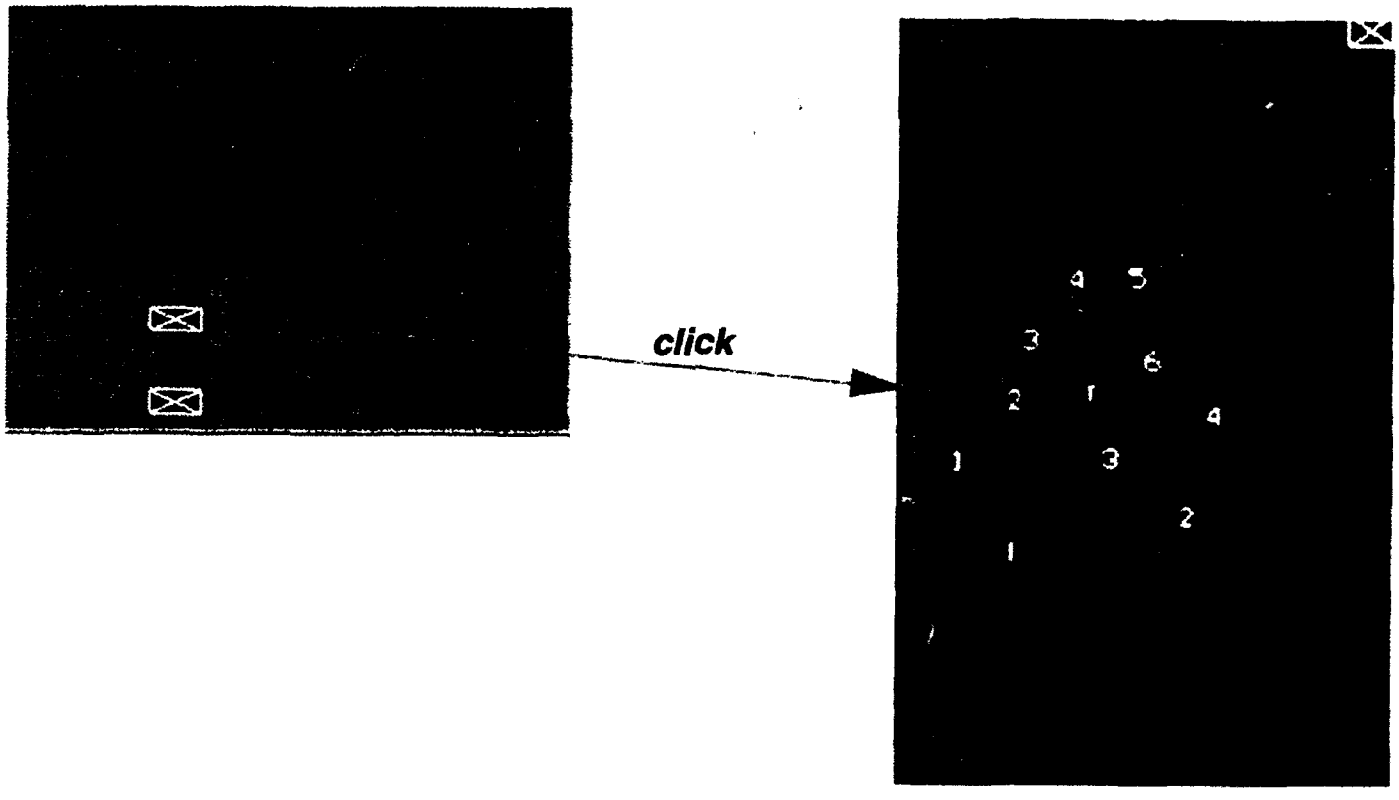


Figure 20. JED pod status and weapon information capability

During the entire JED fire mission, a window is displayed that gives information concerning the Self Propelled Loader Launcher (SPLL) unit to the user. The window, shown below in Figure 21, contains the commanded launcher position, which is the position the launcher unit has been commanded to, and the actual position, which is where the launcher unit actually is. The window also contains the ideal fuse time and the actual fuse time for the JED rockets.

An aimpoint information button is located in the lower portion of the window. By clicking on this button, the user is shown a window containing the position of his aimpoints around the target. In the current interface, an experimental feature was added in the JED fire mission display which enabled the user to mc ve his aimpoints at runtime. Also, in the current interface, no functionality has been assigned to the "next fm" button.

Figure 21. JED launcher position window



During the entire fire mission, a status thermometer, shown below in Figure 22, is displayed indicating to the user where he is in the fire mission.

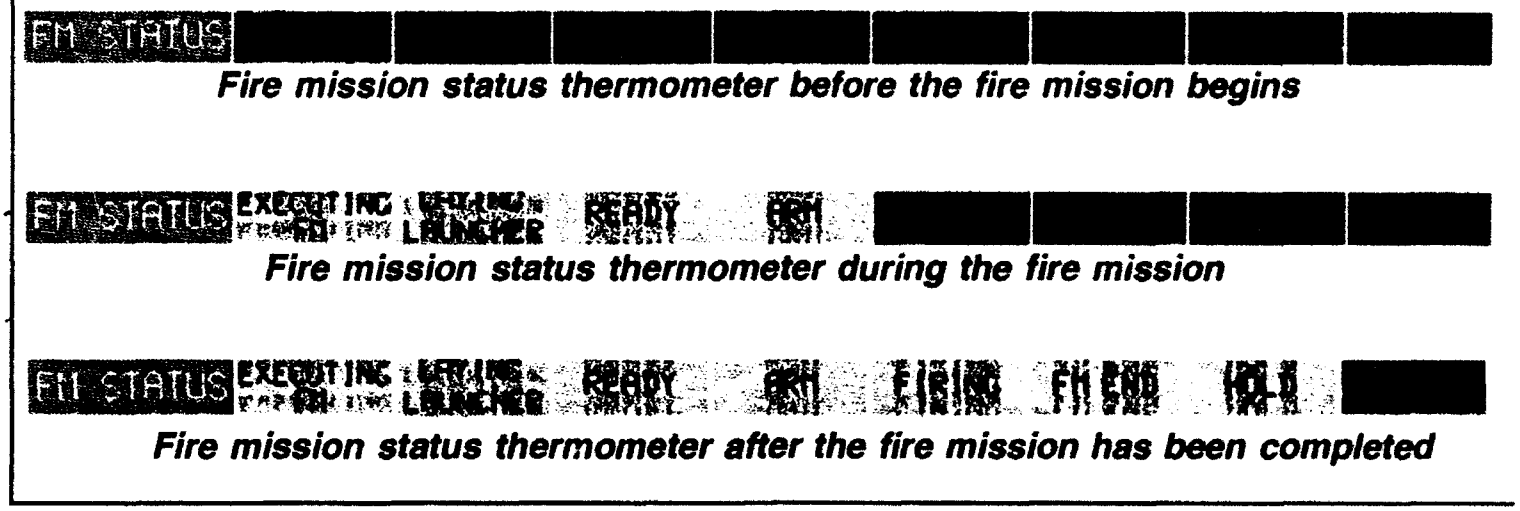


Figure 22. Fire mission status thermometer

As the user completes the criteria for executing a fire mission such as clicking on the launcher lay key and selecting the ready and fire buttons, the thermometer changes to reflect the change in fire mission state. The present state is indicated by a blinking green square. Future states are indicated by a solid green square and states that have been passed through are indicated by a gray square. The current fire mission states are:

State Name	Meaning
Executing FM	Executing Fire Mission
Laying Laucher	The launcher lay button has been selected
Ready	The launcher is in position, the system is waiting for the user to select the ready switch
Arm	The system is waiting for the user to select the arm switch
Firing	The weapons are being fired
FM End	The weapons have been fired, the system is waiting to be safed
Hold	The hold state has not been defined in the current interface
Safe	The launcher has been safed

Inside the JED fire mission display, there is a fire mission information line. The fire mission information line, shown below in Figure 23, contains the target number, firing point information, number of rounds, park heading, and time to fire information given in the fire mission list where the fire mission was selected.

In this example, the target number is AC001, the firing point information can be accessed by clicking on FIRING POINT, the park heading is 4837, the number of rounds is 10, and the time to fire is AMC – At My Command.

Within this line are two buttons, the target information button and the firing pt button. By clicking on the target information button, the user can obtain target point coordinates. By clicking on the firing point button, the user can obtain firing point coordinates.

Figure 23. Fire mission information line

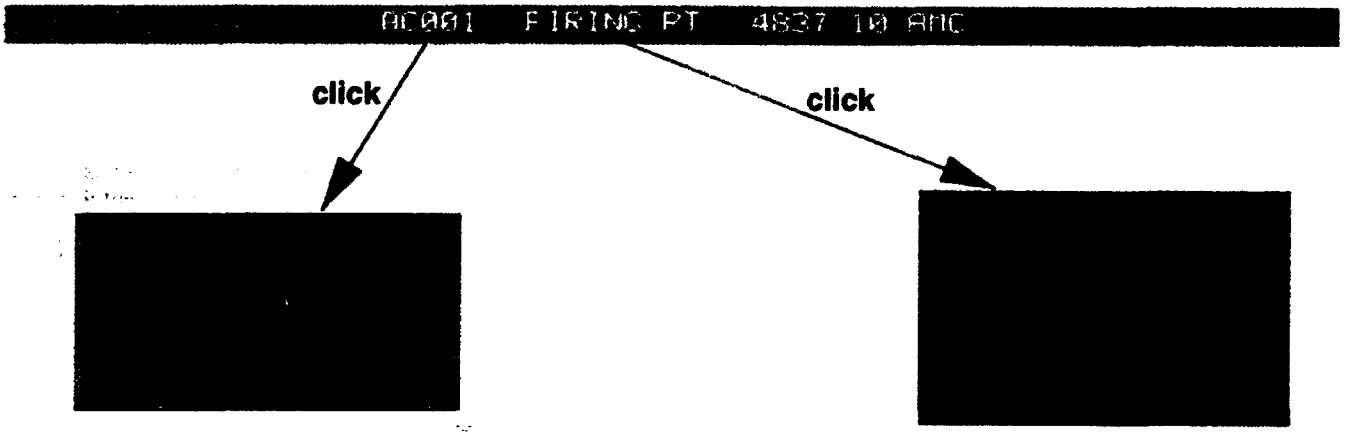
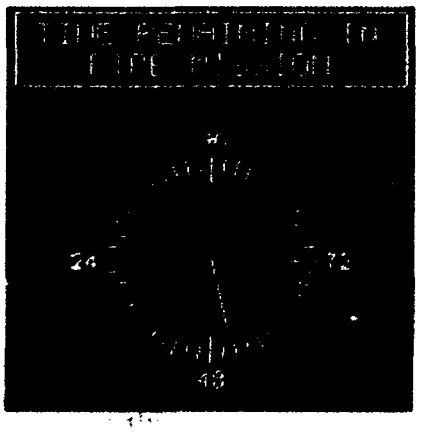


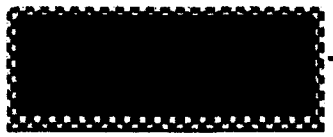
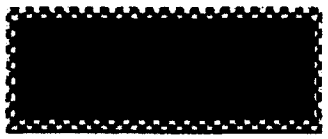
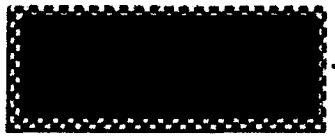
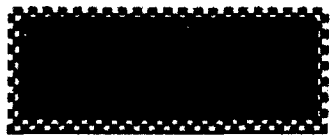
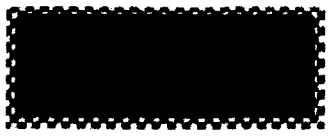
Figure 24. Fire mission clock



As the fire mission begins to execute, an analog fire mission clock appears. The fire mission clock, shown in Figure 24 to the left, informs the user of the time remaining until all of the rockets have been fired. This clock is movable in the current interface since it is large, and the user may need to see important information lying behind it. The clock appears and disappears automatically.

As the fire mission executes, a series of alerts are displayed on the screen. These alerts prompt the user when to select the launcher lay key and select the ready and aim buttons. The alerts also inform the user when the launcher is being laid, when the fire mission has been completed, and when to safe the launcher. The series of alerts is shown below in Figure 25.

Figure 25. Series of fire mission alerts

	Alerts	***Meaning***
1		***This alert prompts the user to select the launcher lay key to continue with the fire mission.***
2		***This alert informs the user that the rocket launcher is moving into position.***
3		***This alert informs the user that the rocket launcher has reached its firing position.***
4		***This alert prompts the user to select the arm button in order to continue with the fire mission. It also informs the user that the GPS is functioning properly.***
5		***This alert prompts the user to select the fire button in order to continue with the fire mission. It also informs the user that the GPS is functioning properly.***
6		***This alert informs the user that the fire mission has begun and rockets are being launched. It also informs the user that the GPS is functioning properly.***
7		***This alert prompts the user to select this stow alert in order to complete the fire mission.***

As mentioned previously, there are six programmable key fields that are displayed at the bottom of the screen at all times. The six programmable key fields correspond to six hard keys that will be present on the IFCS control panel as required by MIS-46307A. After the user chooses to shoot a fire mission, the programmable fields are reprogrammed to reflect the new options that are available to the user, as shown below in Figure 26. In this example, the four programmable key options available to the user are:

Option	Meaning
RETURN TO TOP OPMENU	return to the top-level operational mode display
PREVIOUS MENU	return to previous menu, or the fire mission list
LAUNCHER LAY	the launcher lay key which, when selected, will cause the fire mission to execute
MLRS	at this point, the MLRS key has not been assigned a functionality

Figure 26. Programmable key fields inside the JED fire mission display

The last feature of the JED fire mission display is the JED "fire mission on hold" icon. If a user has selected to shoot a specific fire mission, and he exits the fire mission before it has completed, a fire mission on hold icon will appear on the screen. This icon will remain on the screen until the user elects to abort the fire mission or return to the fire mission at the point where he left. The fire mission on hold icon is shown below in Figure 27.

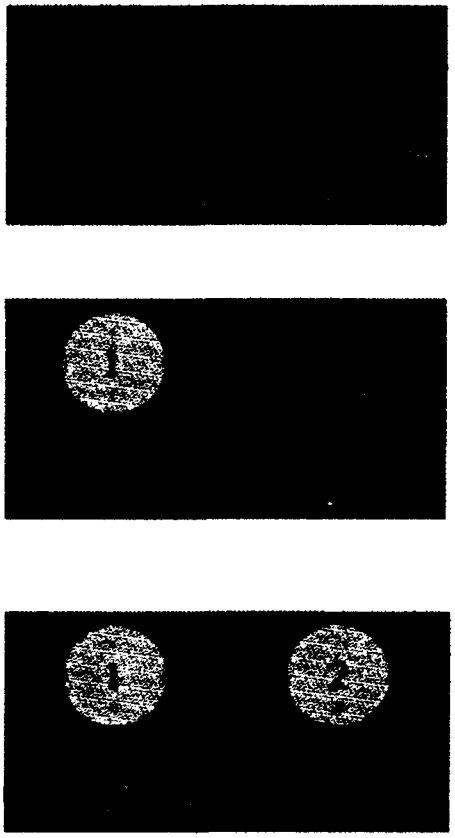
Figure 27. JED fire mission on hold icon

b. Features within a JEE fire mission display

Within the JEE fire mission display, there are several features that have been developed to inform the user of the status of the MLRS IFCS system before, during, and after a fire mission has been selected to fire. These features have been developed by combining graphics and text into an easily understood set of status alerts.

Although most of the features contained within the JEE fire mission display are identical to the features in the JED fire mission display, there are a few differences. The following section will explain the features that do not appear in the JED fire mission section of this report. It will also list in Table 2, below, the features that do appear in the JED fire mission section of this report, and it will direct the user to the appropriate page number for an explanation of each feature's functionality.

Table 2. JEE features that are identical to the JED features previously defined



Before

During

After

Figure 28. JEE pod representation

Functionality

This feature is the **JEE Pod Representation.** In Figure 28, the JEE Pod Representation is seen as the user sees it before, during, and after a fire mission is being fired. Originally, if an ATACMS missile is present in the pod, a green circle will appear. As a missile is fired, the circle will turn gray which alerts the user that a missile has been fired. If a circle is red, the user is alerted to a missile failure. The three conditions that can be identified by the user are:

Color	Condition
Green	JEE present
Gray	Pod is empty
Red	Failure

Another feature that has been built into the JEE pod represesentation is the ability to click on the pod or the "wp type" button and obtain a status report on each individual missile in the pod or obtain weapon information such as type, version number, minimum range and maximum range, etc. The graphical representation of the JEE pod and the resulting information windows are shown in Figure 29, below.

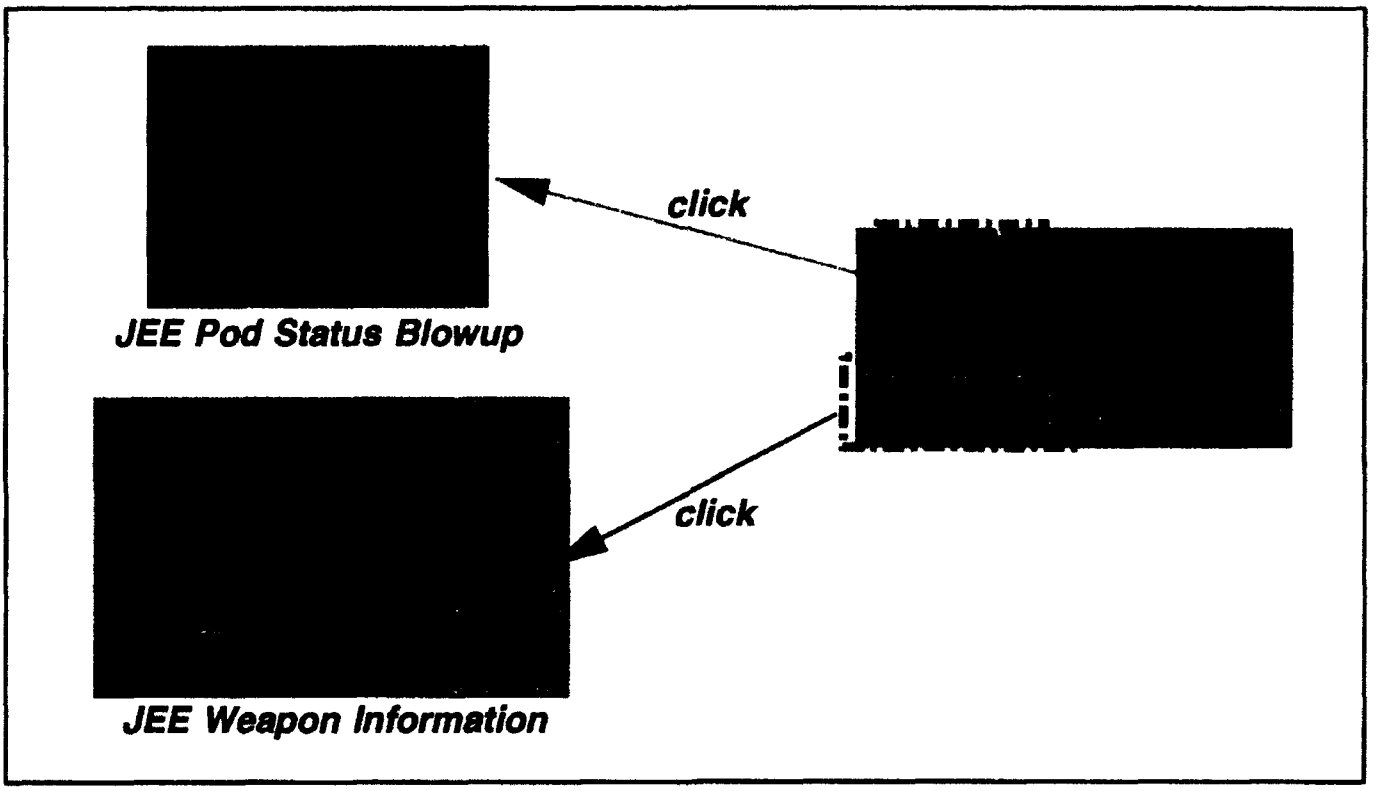


Figure 29. JEE pod status and weapon information capability

Another feature of the JEE fire mission display is the JEE "fire mission on hold" icon. If a user has selected to shoot a specific fire mission, and he exits the fire mission before it has completed, a fire mission on hold icon will appear on the screen. This icon will remain on the screen until the user elects to abort the fire mission or return to the fire mission at the point where he left. The fire mission on hold icon is shown below in Figure 30.

Figure 30. JEE fire mission on hold icon

The last feature in the JEE fire mission display to be discussed is the JEE launcher position window. The JEE launcher position window is displayed during the entire JEE fire mission. This window, shown below in Figure 31, contains the the commanded launcher position, which is the position the launcher unit has been commanded to, and the actual position, which is where the launcher unit actually is. The window also contains the ideal fuse time and the actual fuse time for the JEE missiles.

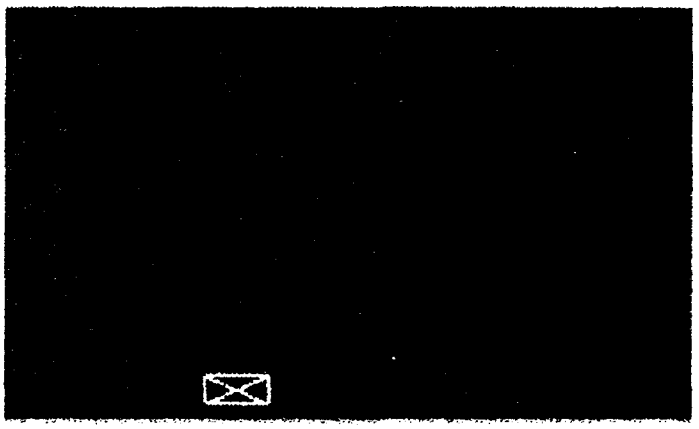


Figure 31. JEE launcher position window

Note that the fundamental difference between the JED launcher position window and the JEE launcher position window is that the JEE launcher position window does not contain an aimpoint information button. The current interface does not support this feature in the JEE fire mission display. Also, in the current interface, no functionality has been assigned to the "next fm" button.

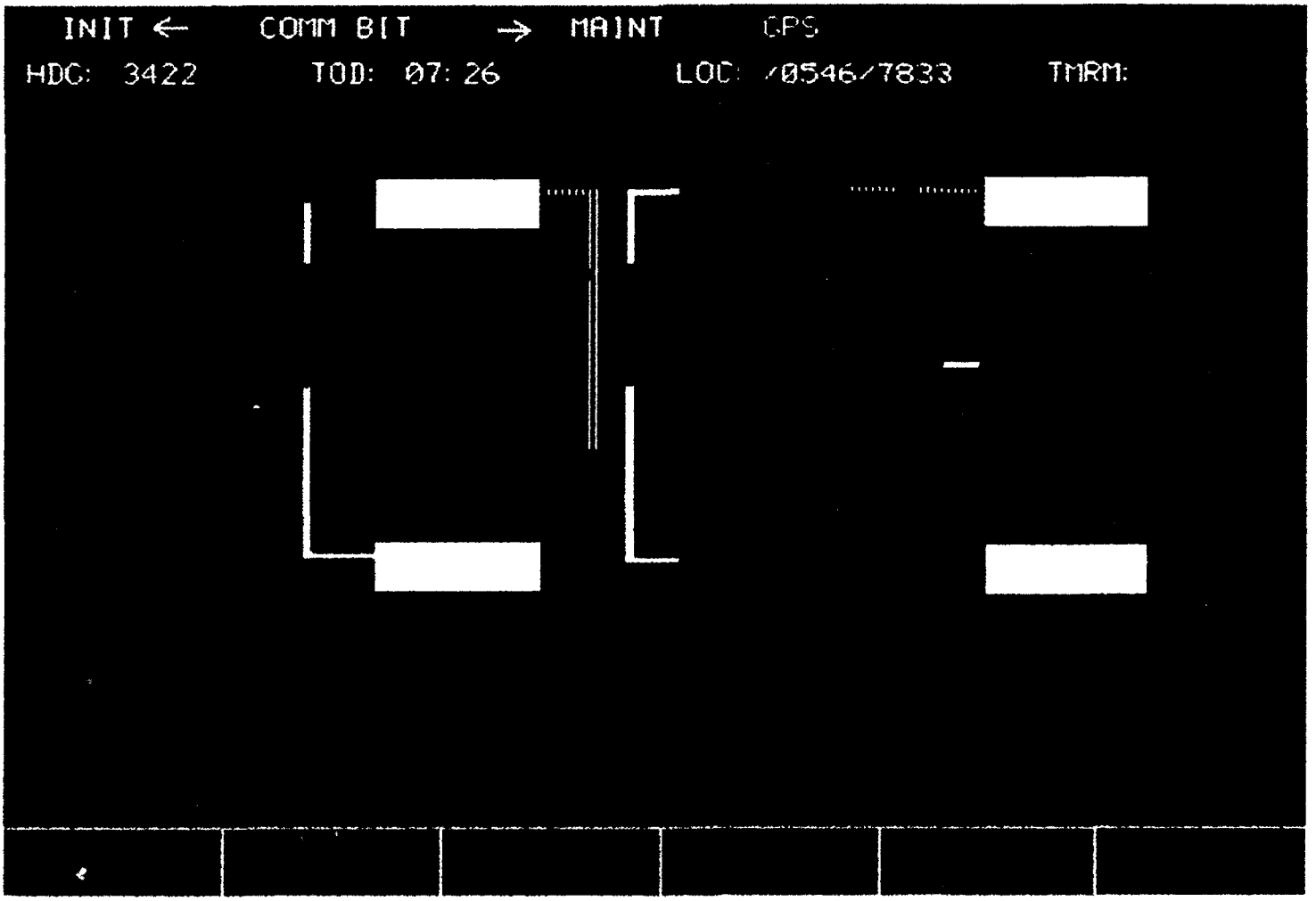
D. Commanded BIT mode

According to MIS-46307A, the Commanded BIT (Built In Test) state is entered from the Initialization state when commanded by the operator. The Commanded BIT state transitions to the Initialization or Maintenance state when commanded by the operator.

Within the Commanded BIT state, the MLRS IFCS can ideally command any LRU to perform its commanded BIT. However, in the current man-machine interface, this functionality has not been assigned to the Commanded BIT mode display. In the current interface, the only options that have been assigned to the Commanded BIT mode are the GPS status capability, the mode transition buttons, and the BIT that can be performed in the power up and initialization modes described previously.

The current display for the Commanded BIT mode is shown below in Figure 32.

Figure 32. Commanded BIT mode display



The three features that have been utilized in the Commanded Bit mode display are the mode transition buttons, the GPS status capability, and the ability to perform power up BIT. For an explanation of the GPS status capability feature and a description of the BIT capability in the power up and initialization modes, see pages 7 – 11.

The mode transition buttons for the Commanded BIT display are shown below in Figure 33.

Figure 33. Mode transition buttons for the Commanded BIT mode display

From the Commanded BIT mode, the user can ideally transition to the Initialization mode or the Maintenance mode. However, since no display has been constructed for the Maintenance mode, this button has not been assigned a functionality. Therefore, the user can only transition to the Initialization mode.

E. Power saver mode

According to MIS–46307A, the Power Saver state can be entered from the Operational state on operator request. Ideally, the Power Saver state can transition to the Power Up state on operator request or when a valid communications message is received. However, since the interface developed for the TRIS effort does not support any realtime interaction with other devices, no communications messages are ever received. Therefore, the transition from the Power Saver state to the Power Up state occurs on operator request.

The current display for the Power Up operational mode is shown below in Figure 34.

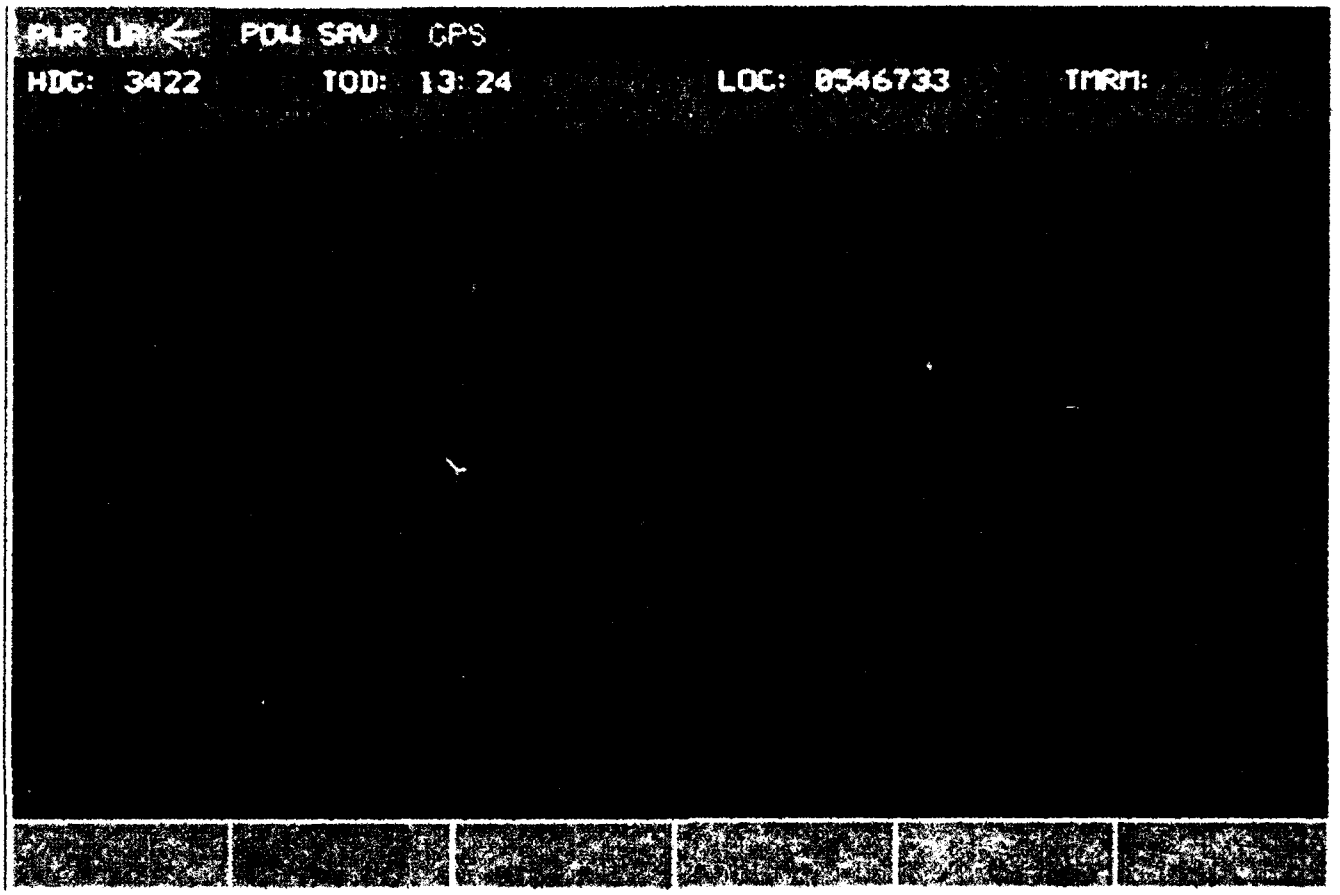


Figure 34. Power saver mode display

The two features that have been implemented in the Power Saver display are the mode transition buttons and the GPS status capability. For an explanation of the GPS status capability feature, see page 10. The mode transition buttons for the Power Saver display are shown below in Figure 35.

Figure 35. Mode transition buttons for the power saver mode display

From the Power Saver mode, the user can transition to the Power Up mode.

F. Maintenance mode

In the current interface, no display has been constructed for the Maintenance mode.

V. Conclusions

As part of the Technical Risk Investigation System (TRIS) effort, a preliminary graphical man–machine interface has been constructed to investigate the risks associated with displaying MLRS IFCS system data using pull–down and pop–up menus, icons and color schemes. Although the current interface developed for the TRIS effort does not represent the complete MRLS IFCS MMI, it does contain a large percentage of the experimental features that are being investigated.

The use of color schemes which are used to signify alerts to the user has been determined to be invaluable in allowing the user to instantly be aware of the status of the system. By alerting the user to problems more quickly, potentially hazardous situations can be avoided. Similarly, pull–down and pop–up menus have proven to be more user–friendly than the conventional method of selecting items from a menu list. Icons were also studied to determine the risks associated with using them in a man–machine interface. It has been determined that a properly designed icon, such as the weapon pod used in the operational mode display and the fire–mission–on–hold icon, can be very helpful in alerting the user to the status of the IFCS system.

Overall, the results of investigating the risks associated with displaying MLRS IFCS system data using pull–down and pop–menus, icons and color schemes have been positive. From this investigation, it has been determined that using these features in the MLRS IFCS MMI will produce an intuitive interface that is more user–friendly and easier to train and learn than the present day FCS.

VI. Recommendations

The recommendations for the MLRS IFCS MMI as a result of the TRIS investigation are:

- Pull–down and pop–up menus are easier to manipulate than a series of menu lists. Therefore, the use of pull–down and pop–up menus is recommended for the MLRS IFCS MMI.

- Icons are intuitive and, if properly designed, they allow the user to see the status of the system at a glance. Therefore, the use of icons is recommended for the MLRS IFCS MMI.

- Color schemes can be vital in alerting a user of a potentially hazardous condition within a system. Very often, an obscure alert message on the bottom line of a screen might be overlooked or a constantly blaring horn might be ignored after becoming a familiar sound. By using flashing red lights on the screen to alert the user to danger and other colored objects to indicate system status, the user can be instantly aware of problems with the system. Therefore, the use of color schemes is recommended for the MLRS IFCS MIMI.

APPENDIX A

List of Acronyms

List of Acronyms

Acronyms	Meaning
ATACMS	Army Tactical Missile System
BIT	Built In Test
CCA	Circuit Card Assembly
CMP	Communication Processor
COMMS	Communications
CON	Method of Control
FCP	Fire Control Panel
FCS	Fire Control System
FM	Fire Mission
FM#	Fire Mission Number
FP	Firing Point
GPS	Global Positioning System
IFCS	Improved Fire Control System
JED	Fire Support Weapons name for the M77 rocket
JEE	Fire Support Weapons name for the ATACMS missile
LAUNCH ST	Launcher Status
LIU	Launcher Interface Unit
LRU	Line Replacable Unit

List of Acronyms (cont.)

Acronyms	Meaning
MLRS	Multiple Launch Rocket System
MMI	Man-Machine Interface
MP	Main Processor
MS	Meteorological Sensor
MSD	Mass Storage Device
NAV	Navigation
PH	Park Heading
PMU	Power Management Unit
POS/NAV	Position Determining/Navigation
RAM	Random Access Memory
SPLL	Self Propelled Loader Launcher
TG#	Target Number
TRIS	Technical Risk Investigation System
TTF	Time To Fire
VAPS	Virtual Applications Prototyping Systems
WIU	Weapon Interface Unit

List of Acronyms (cont.)

Acronyms	Meaning
WP ST	Weapon Status
WPU	Weapon Power Unit
#RNDS	Number of Rounds to Fire

APPENDIX B

Graphical Interface Program Code

The code that has been written to implement the MLRS IFCS MMI has been generated using the Augmented Transition Network Language (ATN Language) of VAPS. The ATN language has been developed by VPI for use with their prototyping package, and according to the VAPS Programmer's Guide, describes a series of states that a modelled system takes in response to events generated from "outside." For further information about the ATN language, refer to the VAPS Programmer's Guide.

The code generated for the MLRS IFCS MMI can be found on the Silicon Graphics 4D/310VGX machine alias name c3t-310vgx located in Building 4381, Trailer 4 under:

/proj/people/mary/ifcs_final_code.ATN

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